Intel oneAPI Toolkits

Ronald W. Green, Manager Compiler Support
Agenda

- Intel® oneAPI Initiative
- Intel® oneAPI Toolkits
- Intel® Compilers in oneAPI Toolkits
- Using OpenMP® with Intel® Compilers
- Where to go to get Intel® oneAPI Compilers
oneAPI Industry Initiative
Alternative to Single-Vendor Solution

Open standard to promote community and Industry support

Specifies Language, APIs, Low level Hardware Interface

Enables code reuse across architectures and vendors

Open call for comments at oneAPI.com
Intel® oneAPI Toolkits

TOOLKITS TAILORED TO YOUR NEEDS

Domain-specific sets of tools to get your job done quickly.

- **Intel® oneAPI Base Toolkit**
  A core set of high-performance tools for building Data Parallel C++ applications and oneAPI library based applications

- **Intel® oneAPI HPC Toolkit**
  Everything HPC developers need to deliver fast C++, Fortran, & OpenMP® applications that scale

- **Intel® oneAPI IoT Toolkit**
  Tools for building high-performance, efficient, reliable solutions that run at the network’s edge

- **Intel® oneAPI Rendering Toolkit**
  Powerful rendering libraries to create high-performance, high-fidelity visualization applications

- **Intel® oneAPI DL Framework Developer Toolkit**
  Tools for developers & researchers who build deep learning frameworks or customize existing ones so applications run faster

- **Intel® System Bring-Up Toolkit**
  Tools to debug & tune power & performance in pre- & post-silicon development

- **Intel® Distribution of OpenVINO™ Toolkit**
  Tools to build high performance deep learning inference & computer vision applications (production-level tool)

- **Intel® AI Analytics Toolkit**
  Tools to build applications that leverage machine learning & deep learning models

Toolkits Powered by oneAPI
Next Generation – The Same and MORE!

- All Parallel Studio Components today will be available in oneAPI Toolkits with New Stuff!
- Support continues without interruption
- \textit{BETA today, Gold by end of Q4 2020}
Shopping for the RIGHT Compiler for You!

Intel® Compilers in Toolkits

Decoding your Intel® Compiler Choices
Key Concepts for Intel® Compilers Going Forward

• New Underlying Back End Compilation Technology based on LLVM
• New compiler technology available today in oneAPI Beta for DPC++, C++ and Fortran
• Existing Intel proprietary “IL0” (ICC, IFORT) Compilation Technology compilers provided alongside new compilers
  • CHOICE! Continuity!
  • **BUT Offload (DPC++ or OpenMP TARGET) supported only with new LLVM-based compilers**
Packaging of Compilers

- PSXE 2020 for Continuity
  - **Drivers:** icc, icpc, ifort
  - **v19.1 Compiler versions; 19.1 branch**

- oneAPI Base Toolkit (BETA) **PLUS** oneAPI HPC Toolkit (BETA)
  - Existing IL0 compilers ICC, ICPC, IFORT in HPC Toolkit
    - **v2021.1 code base; IL0 mainline code branch**
  - **ADDED! New compilers based on LLVM* framework**
    - **Drivers:** icx, ifx and dpcpp
    - **v2021.1 code base; new compilers mainline code branch (at this time)**
## Intel® Compilers – Target & Packaging

<table>
<thead>
<tr>
<th>Intel Compiler</th>
<th>Target</th>
<th>OpenMP Support</th>
<th>OpenMP Offload Support</th>
<th>Current Status (Sep 2020)</th>
<th>Release Q4’20</th>
<th>Included in oneAPI Toolkit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intel® oneAPI DPC++/C++ Compiler (dpcpp)</td>
<td>CPU, GPU, FPGA*</td>
<td>No</td>
<td>No</td>
<td>Beta</td>
<td>Production</td>
<td>Base</td>
</tr>
<tr>
<td>Intel® C++ Compiler, IL0 (icc)</td>
<td>CPU</td>
<td>Yes</td>
<td>No</td>
<td>Production** + Beta</td>
<td>Production</td>
<td>HPC</td>
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<tr>
<td>Intel® oneAPI DPC++/C++ Compiler Pro (icx)</td>
<td>CPU, GPU*</td>
<td>Yes</td>
<td>Yes</td>
<td>Beta</td>
<td>Production</td>
<td>HPC</td>
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<tr>
<td>Intel® Fortran Compiler, IL0 (ifort)</td>
<td>CPU</td>
<td>Yes</td>
<td>No</td>
<td>Production** + Beta</td>
<td>Production</td>
<td>HPC</td>
</tr>
<tr>
<td>Intel® Fortran Compiler (ifx)</td>
<td>CPU, GPU*</td>
<td>Yes</td>
<td>Yes</td>
<td>Beta</td>
<td>Production</td>
<td>HPC</td>
</tr>
</tbody>
</table>

*Cross Compiler Binary Compatible and Linkable!

*Intel® Platforms

**PSXE 2020 Production, oneAPI HPC Toolkit (BETA)
Essential Takeaways for OpenMP Programmers

- The Intel® Compilers with OpenMP support are packaged in the Intel® oneAPI HPC Toolkit (BETA). BUT ....

- ICX (C/C++) needs Intel® oneAPI Threading Building Blocks which is in Intel® oneAPI Base Toolkit
  
  - And You probably want MKL, Vtune, Advisor : also in Base Toolkit

- AND ... For offload to Intel GPUs you need device drivers for your supported OS and hardware

  https://dgpu-docs.intel.com/installation-guides/index.html


Let's Get Started!

Using OpenMP®

Intel® Compilers for OpenMP
OpenMP with Intel® Compilers

- **Drivers**
  - icx (C/C++) ifx (Fortran)

- **OPTIONS**
  - `-fiopenmp`
    - Selects Intel Optimized OMP
  - `-fopenmp` for Clang* O.S. OMP
  - `-qopenmp` NO!! rejected, only in ICC/IFORT

  `-fopenmp-targets=spir64`
  - Needed for OMP Offload
  - Generates SPIRV code fat binary for offload kernels

- **Setting up environment**

  ```
  source <inst dir>/setvars.sh
  ```

  - Sets up env vars for all tools.
  
  OR

  ```
  source \<inst dir>/compiler/latest/env/vars.sh
  ```

  "latest/" or specific version

  - Other components also similar

  ```
  <inst dir>/mkl/latest/env/vars.sh
  ```

  Modulefiles also provided for each component in ...

  ```
  <inst dir>/modulefile-setup.sh creates <inst dir>/modulefiles
  ```
Essential Intel env Var LIBOMPTARGET PROFILE

- OpenMP Standard ENV vars are accepted. Add to this list ...
- `export LIBOMPTARGET PROFILE=T`

  - performance profiling for tracking on GPU kernel start/complete time and data-transfer time.

```
GPU Performance (Gen9, export LIBOMPTARGET PROFILE=T, usec)

... ...
Kernel Name: __omp_offloading_811_29c8c383__ZN12BlackScholesIdE12execute_part_1368
iteration #0 ...
calling validate ... ok
calling close ...
execution finished in 1134.914ms, total time 0.045min
passed

LIBOMPTARGET PROFILE:
-- DATA-READ: 16585.256 usec
-- DATA-WRITE: 9980.499 usec
-- EXEC-__omp_offloading_811_29c8c383__ZN12BlackScholesIdE12execute_part_1368: 24048.503 usec
```
Debug RT env Var LIBOMPTARGET_DEBUG

- Export LIBOMPTARGET_DEBUG=1

  - Dumps offloading runtime debugging information. Its default value is 0 which indicates no offloading runtime debugging information dump.

  ./matmul

  Libomptarget --> Loading RTLs...
  Libomptarget --> Loading library 'libomptarget.rtl.nios2.so'...
  Libomptarget --> Loading library 'libomptarget.rtl.x86_64.so'...
  Libomptarget --> Successfully loaded library 'libomptarget.rtl.x86_64.so'!
  Libomptarget --> Loading library 'libomptarget.rtl.opencl.so'...

  Target OPENCL RTL --> Start initializing OpenCL
  Target OPENCL RTL --> cl platform version is OpenCL 2.1 LINUX
  Target OPENCL RTL --> Found 1 OpenCL devices
  Target OPENCL RTL --> Device#0: Genuine Intel(R) CPU 0000 @ 3.00GHz

  ... AND MUCH MORE ...
For Latest Information

- Get Started with OpenMP* Offload Feature to GPU for the Intel® C++ Compiler and Intel® Fortran Compiler

Let's Get Started!

Getting Toolkits
Accessing oneAPI Toolkits/Components

- Intel® oneAPI Toolkits (Beta)
- Intel® DevCloud
- Online Learning Resources
Get the Intel® oneAPI Toolkits

Intel® oneAPI Toolkits (Beta)
Deliver uncompromised performance for diverse workloads across multiple architectures.

Expanded Component Accessibility and Acquisition

• Intel® oneAPI Toolkit Components at Gold launch will be available through:
  • Intel® Registration Center
  • NuGET
  • APT & YUM Repositories (beta available today)
  • Zyper (beta available today)
  • Docker Containers (beta available today – Docker Hub)

Intel® DevCloud for oneAPI

- A development sandbox to develop, test and run workloads across a range of Intel CPUs, GPUs, and FPGAs using Intel’s oneAPI beta software
- For customers focused on data-centric workloads on a range of Intel CPUs, GPUs, and FPGAs

NO DOWNLOADS | NO HARDWARE ACQUISITION | NO INSTALLATION | NO SET-UP & CONFIGURATION

GET UP & RUNNING IN SECONDS!

software.intel.com/devcloud/oneapi
Start Learning DPC++

Get hands-on practice with code samples in Jupyter Notebooks running live on Intel DevCloud.

Learning Modules to Experience DPC++

- DPC++ Program Structures
- DPC++ Unified Shared Memory
- DPC++ Sub-Groups
- Demonstration of Intel® Advisor
- Intel® VTune™ Profiler

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